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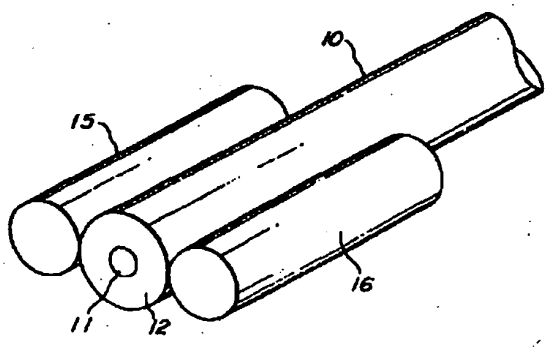
(54) Optical fiber having elliptical lens and method of producing the same.

(57) An optical fiber having an elliptical lens comprises a main body (10) and two fiber pieces (15, 16) embracing one end of the main fiber body (10) therebetween and extending substantially in parallel with said main fiber body (10). The elliptical lens is formed by fused ends of the main fiber body (10) and the fiber pieces (15, 16). A method of producing an optical fiber having an elliptical lens comprises steps of arranging two fiber pieces (15, 16) substantially in parallel with and on both sides of an optical fiber (10) and adjoining and embracing one end of the optical fiber (10) and heating and fusing ends of the optical fiber (10) and the fiber pieces (15, 16) to form the elliptical lens by the fused portions thereof with the aid of surface tension. Light beams are effectively introduced into the optical fiber through the elliptical lens.



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This invention relates to an optical fiber formed on its end with an elliptical lens and a method of producing the same.

In order to introduce output light beams from laser diodes into optical fibers effectively, it has been proposed that one end of an optical fiber is heated so as to soften to form a hemispherical lens through which light beams are collected.

In consideration of light emission of the laser diode, the vertical transverse mode has usually a wider spread angle than that of the horizontal transverse mode, so that the light emission pattern is elliptical.

Among the hitherto used fibers formed with hemispherical lenses, those having circular light emission patterns exhibit high light collecting efficiencies. However, those having elliptical light emission patterns do not exhibit sufficient light collecting efficiencies. The introduction of output light beams of laser diodes into optical fibers with high efficiencies results directly in elongation of transmission distance achieved without using relay, so that communication cost is lowered. Moreover, if the optical fiber receives larger input, the signal to

noise (SN) ratio is improved, so that the bit error rate is made better resulting in higher reliability in communication circuits.

As can be seen from the above description, it is an important problem to be solved that the output of the laser diode is effectively introduced into optical fibers. In order to solve this problem, it has been studied to use laser diodes whose light emission patterns are circle. However such laser diodes do not solve the problem completely. There has been a method of optically assisting the introduction of the output of the laser diode into the optical fibers with the aid of a combination of cylindrical lenses. However, it is difficult to apply this method to communication circuits due to shapes and alignments of the cylindrical lenses.

It is a principal object of the invention to provide an optical fiber having an elliptical lens and a method of producing the same which eliminate all the disadvantages of the prior art.

In order to achieve this object, the optical fiber having an elliptical lens according to the invention comprises a main fiber body and two fiber pieces embracing one end of said main fiber body therebetween and extending substantially in parallel with said main fiber body and the elliptical lens formed by fused ends of said main fiber body and said fiber pieces.

The method of producing the optical fiber

having an elliptical lens according to the invention comprises steps of arranging two fiber pieces substantially in parallel with and on both sides of an optical fiber and adjoining and embracing one end of the optical fiber, and heating and fusing ends of the optical fiber and the fiber pieces to form the elliptical lens by the fused portions thereof with the aid of surface tension.

In a preferred embodiment, the ends of the optical fiber and the fiber pieces are heated by electrical discharge or a micro-torch.

The fiber pieces are preferably selected so as to be superior in affinity with the optical fiber under fused condition.

A ratio of diameter of the fiber pieces to diameter of the optical fiber is changed to vary the curvature of the elliptical lens.

According to the invention, when the optical fiber and the two fiber pieces are softened and fused, the optical fiber is subjected on its both ends to tensile forces owing to affinity between the fused portions to form an elliptical lens. In this manner, even if the output of the laser diode exhibits an elliptical light emission pattern, the output can be effectively introduced into the optical fiber.

In order that the invention may be more clearly understood, preferred embodiments will be described, by way of example, with reference to the accompanying drawings.

Figs. 1a, 1b and 1c illustrate an optical fiber having an elliptical lens according to the invention;

Fig. 2a is a perspective view of an optical fiber for explaining the method of producing the fiber having an elliptical lens; and

Fig. 2b is a side view of the optical fiber shown in Fig. 2a.

Figs. 1a, 1b and 1c illustrate an optical fiber formed on its end with an elliptical lens according to the invention in a front, plan and side view, respectively.

The optical fiber 10 comprises a core 11 and a clad 12 to form a main fiber body and fiber pieces 15 and 16. Front ends of the fiber pieces 15 and 16 are integrally fused with a front end of the optical fiber 10 to form the elliptical lens.

Figs. 2a and 2b illustrate in a perspective and front view a method of producing the optical fiber having the elliptical lens shown in Figs. 1a-1c. The fiber pieces 15 and 16 are arranged one either side of the front end of the optical fiber 10.

The front ends of the optical fiber 10 and the fiber pieces 15 and 16 are heated by electrical discharge, micro-torch or the like to be sufficiently softened or fused. In this case, it is of course preferable to select fiber pieces 15 and 16 which are superior in affinity with the optical fiber 10 under

fused conditions.

Upon heating and fusing the front ends of the optical fiber and fiber pieces, the fiber pieces 15 and 16 are fusing at the front end of the optical fiber 10, while both sides of the optical fiber 10 are subjected to tensile forces due to surface tension of the fused fiber pieces to form an elliptical lens at the front end of the optical fiber as shown in Figs. 1a-1c.

A curvature of the elliptical lens can be varied by changing a ratio of diameter of two fiber pieces 15 and 16 to diameter of the optical fiber 10.

Although the optical fiber 10 is a step index fiber, this is only by way of example, and it is clear a graded index optical fiber can bring about the same effect as that in the above embodiment.

It should be understood that the fiber pieces may be removed after the elliptical lens has been formed.

As can be seen from the above explanation, the optical fiber produced by the method according to the invention comprises the elliptical lens at its end which is very small and convenient in use with high efficiency in collecting light beams, thereby improving the transmission of long distances and the signal to noise ratio. Accordingly, the invention has great effects in the industrial field.

It is further understood by those skilled in the art that the foregoing description is that of

preferred embodiments of the disclosed fibers and that various changes and modifications may be made in the invention without departing from the spirit and scope thereof.

Claims

1. An optical fiber having an elliptical lens comprising a main fiber body (10) and two fiber pieces (15,16) embracing one end of said main fiber body therebetween and extending substantially in parallel with said main fiber body and the elliptical lens formed by fused ends of said main fiber body and said fiber pieces.

2. A method of producing an optical fiber having an elliptical lens comprising steps of arranging two fiber pieces(15,16) substantially in parallel with and on both sides of an optical fiber (10) and adjoining and embracing one end of the optical fiber, and heating and fusing ends of the optical fiber and the fiber pieces to form the elliptical lens by the fused portions thereof with the aid of surface tension.

3. A method as set forth in claim 2, wherein the ends of the optical fiber (10) and the fiber pieces (15,16) are heated by electrical discharge.

4. A method as set forth in claim 2, wherein the ends of the optical fiber (10) and the fiber pieces (15,16) are heated by a micro-torch.

5. A method as set forth in claim 2, wherein the fiber pieces (15,16) are superior in affinity with the optical fiber (10) under fused condition.

6. A method as set forth in claim 2, wherein a ratio of diameter of the fiber pieces (15,16) to diameter of the optical fiber (10) is changed to vary the curvature of the elliptic l lens.

FIG_1a

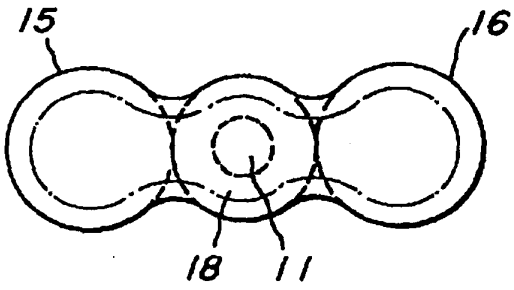

FIG_1c

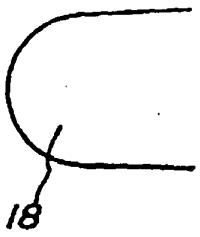

FIG_1b

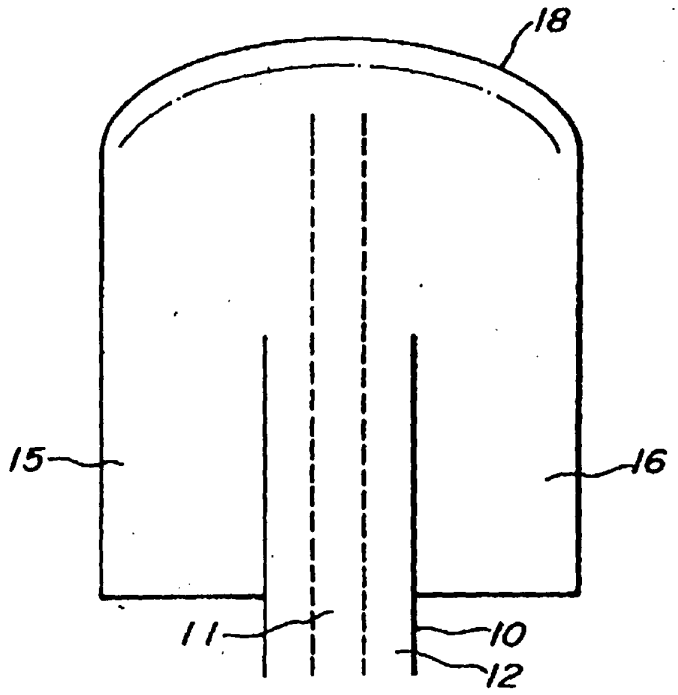

FIG_2a

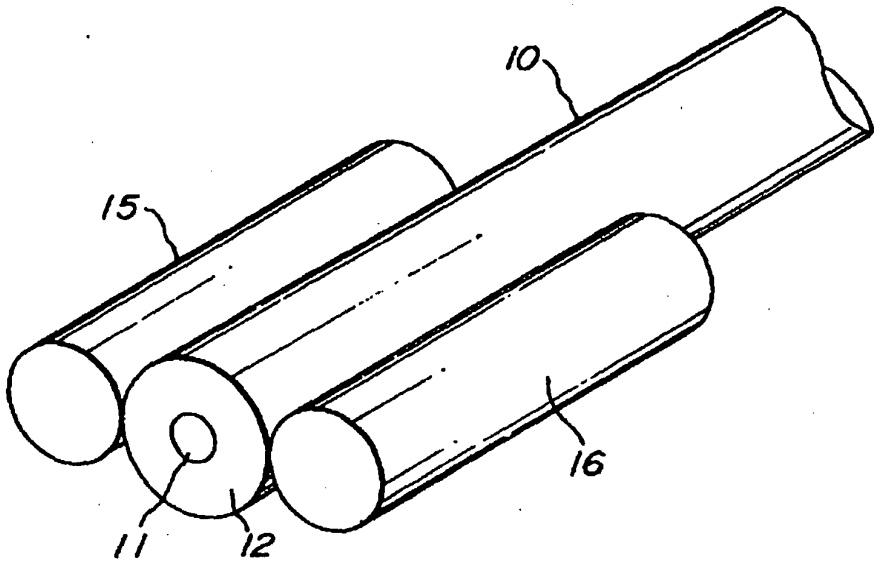

FIG_2b